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ABSTRACT

A number of researchers in cognitive science have proposed reasons as to why collaborative learning is more efficient than learning alone. The study of collaborative learning has shifted in focus to the relationship between the process of collaboration itself and the learning results. This study focuses on the latter. The study proposes two elements that were encountered during analysis of cross-age tutoring investigations. The first is that both learners' questions and tutors' advice is representative of their externalized metacognitive experience. The second is the manner in which interaction between learners and tutors develops the learner's monitoring abilities. If learners notice differences in meaning in the responses tutors give to learners' questioning and perform conscious cognition of the tutor's externalized metacognitive experiences, the learner's reflective thinking caused by the tutor's responses produces the learner's monitoring as affected by the tutor's criterion. (AEF)

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Tutee's Reflective Thinking of Tutor's Response Produces Monitoring

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Abstract: This study proposes two elements that were encountered during analysis of cross-age tutoring investigations. The first is that both learners' questions and tutors' advice is representative of their externalized metacognitive experiences. The second is the manner in which interaction between learners and tutors develops the learner's monitoring abilities. If learners notice differences in meaning in the responses tutors give to learners' questioning and perform conscious cognition of the tutor's externalized metacognitive experiences, the learner's reflective thinking caused by the tutor's responses produces the learner's monitoring as affected by the tutor's criterion.

Introduction

Recently the view of learning has changed from the "transference of knowledge" to "constructing knowledge through interaction with the external world including others". Traditionally teachers have been about the task of transferring their knowledge. The important concern for the teacher was the organization of knowledge so those learners could learn effectively. However, the new view of learning considers that learners construct knowledge by their own processes through evaluation and improvement of their own knowledge. Concurrently they are learning how to learn as well.

Under the new view of learning, many researchers focus on the role of others in the external world. They have tried to practice collaborative learning. Collaborative learning is defined as learners working on a task together. However it is yet unclear whether collaboration improves learning. There is some research supporting the view that low achievers progressively become passive while collaborating with high achievers (Mulyran 1992).

A number of researchers in cognitive science have proposed reasons as to why collaborative learning is more efficient than learning alone. The aim of the early studies of collaborative learning was to determine the conditions under which collaborative learning is efficient. Experiments were conducted to answer the question: "Under what conditions is collaborative learning efficient?" rather than "Which interactions occur under which conditions" or "What kind of effects do these interactions cause?" They have considered conditions such as the composition of the group, the features of the task, the context of collaboration and so on. However these conditions were very complicated and inter-connected. Thus it was difficult for researchers to identify the relationship between the conditions and the effects. Consequently the study of collaborative learning has shifted in focus to the relationship between the process of collaboration itself and the learning results.

Our focus is on the latter. We envisage how and why interaction in the collaborative process progresses participants' metacognitive experience on the assumption that collaboration develops participants' metacognitive experience. This term, metacognitive experience, is based on Nelson and Narens metacognitive system model of monitoring and control.

Nelson and Narens proposed a metacognitive system model in which they split the cognitive process into two or more specifically interrelated levels. The most simple metacognitive system model consists of two interrelated levels; the meta-level and the object-level. Furthermore, the metacognitive system model has a kind of dominance relationship, which is defined by the direction of the flow of information; monitoring and control. Monitoring occurs when the meta-level is informed by the object-level; control occurs when the meta-level modifies the object-level (Nelson & Narens 1994).

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In this study, we propose the following two points which were found through analysis of cross-age tutoring. First we propose that learners' questions and the tutors' responses are representative of their metacognitive experience. Second we propose in the process of cross-age tutoring that tutors cause the learners' metacognitive experience to progress.

Section 2 describes the cross-age tutoring practices and representative dialogs. Section 3 illustrates the relationship between learners' questions and tutors' suggestions and their metacognitive experience. Section 4 delineates the process of the cross-age tutoring that tutors cause the learners' metacognitive experience to progress.

Cross-age tutoring practice and dialog

First, let us make a distinction between collaboration and cooperation. We cite the following definition by Roschelle and Teasley (Roschelle & Teasley, 1994).

> "Collaboration is a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem. Cooperation is accomplished by the division of labor among participants, as an activity where each person is responsible for a portion of the problem solving."

We designed a cross-age tutoring situation for use on a computer network between the Department of Engineering and the Department of Art at Tamagawa University. The 6 senior students in the Department of Engineering tutored the 34 first year students in the Department of Art. The first year students had no particular level of computer literacy.

Two tasks were assigned. The first task was to learn new terms that are encountered in computer science. As examples:

1. RAM: random access memory,
2. ROM, read only memory, and so on.

The second task was for the first year students to create Web Pages to explain their interpretation of the terms encountered in computer science. Requesting this explanation of terms allowed the students to engage in furthering constructive knowledge.

This "class" term was for six weeks. In the first task, most students did not understand the terms encountered. Additionally most students were unable to explain the terms as assigned in the second task. They required further help from senior students in the Department of Engineering using Bulletin Board Services [BBS]. Senior students tutored them through the BBS. By using the BBS for their communications all students were able to have access to all questions and suggestions. The tutors were not given any specific instructions about how to do their teaching. They were only told to help the first year students.

The content of the interactions was recorded on the BBS. Following we will show some examples of natural discourse indicating how knowledge was constructed in cross-age tutoring.

Questions that request information

All university students asked questions that request information such as "What is a modem?" in the first lesson.

Question 1:
Although we have researched SCSI, we do not understand it. Please explain it to us simply.

Question 2:
Hi, it is hot today. How are you doing? I have researched about floppy disks. However, I have little knowledge. Please help me. Please explain about floppy disks in words that I can understand.

Question 3:
Let us know about CD-ROMs in simple terms.

Most students were sure someone would answer their questions and could copy those answers.

Criticism of questions that request information

In answer to these questions that requested information, one tutor gave the following severe criticism. The tutor was aware of who the learner was who asked the question requesting information on BBS. In his interview, he criticized her for not trying to answer the question herself. She wanted help too quickly.

Criticism 1:
Do it yourself. Have you looked it up in books or dictionaries? You should ask questions only after you've done some research and make your question more specific. Don't ask such vague questions.

Explanation on questions that request information

Another tutor gave a detailed explanation of over three pages.

Explanation 1:
I took note of the severe criticism you received. Concerning SCSI, it means Small Computer Systems Interface. That is the interface's standard connection between the computer and different devices.

After writing this explanation, this tutor became aware of many questions that requested information on the BBS. And he remembered that he had requested information two years prior. Thus he thought he should advise learners on how to ask more specific questions. Then he and the other tutors began to give the learners their advice.

Advice on questions that request information

Advice 1:
I guess you are confused about how to ask for help. When I was a junior student I asked questions like yours...You should make clearer the things you are uncertain of when you ask somebody for help. Even if you ask "Let me know about SCSI", we can not explain it all. It is too vague.

Advice 2:
Hi, you know about CPUs don't you? I don't know for certain what you know about CPUs. I had no computer literacy either when I was a junior. I know that you asked, "What is a CPU?" However you should make clear the things you don't know when you ask somebody for help. There are a lot of magazines about computer literacy and they explain things in simpler terms than many books do. Thus there are explanations about CPUs in magazines. Please read them. If you have questions after reading them, I can help you.

Advice 3:
I guess you need to have some fundamental knowledge and to search for one thing at a time. You should make clear the things you don't know when you ask somebody for help. If you make the uncertain things clear you will be successful and will enjoy learning. This is my advice as a senior.

Questions that confirm interpretation

In response to this advice, questions that requested information were transformed into questions that confirmed interpretation. Questions that confirm interpretation are questions that learners ask in order to confirm their own comprehension.

Question 4:
I suppose that all information is represented as one or zero. If so, is hiragana or katakana[1] represented as one or zero?

Question 5:
I have researched and come to an understanding of the term "Hard Disk". "Hard Disk" is ÖLet us know

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[1] Hiragana and katakana are Japanese phonetic alphabets.

more information about it, for example, the merits or the demerits and so on.

Questions, the response and the metacognition

Useful metacognitive experiences may be engendered by communication loosely and broadly defined. Metacognitive experience may be engendered by paraphrasing, finding examples, or asking questions about what we have tried to comprehend in order to find out how correctly and fully we have comprehended it (Flavell 1981). These actions are communicative attempts to talk to ourselves or to others. Therefore the learners' questions and tutors' responses are related to their metacognitive experience (Kayashima 1998).

Additionally, Artzt & Armour-Thomas have claimed the difficulty in problem solving may lie in a student's inability to actively monitor and subsequently regulate the cognitive process engaged in during problem solving (Artzt & Armour-Thomas 1992). They reported that the group that did not solve the problem consisted of the members who had the lowest percentage of episodes at the metacognitive level and highest percentage of episodes at the cognitive level. Based on Flavell's idea mentioned above, we could rephrase their results as follows: the communication between the members, who belonged to the group that did not solve the problem, could not engender their metacognitive experiences.

On the contrary, the communication between the members, who belonged to the group that solved the problem, could engender their metacognitive experiences. Their metacognitive experiences affected their cognitive objectives and their cognitive actions; thus they were able to solve the problem.

Hence, we try to analyze the learners' questionings and the tutors' responses from the viewpoint of their metacognitive experience in order to verify how the interactions between learners and tutors develop their metacognitive experiences.

Questions represent learners' immediate antecedent action of questionings

We categorized learners' questions into "questions that request information" and "questions that confirm interpretation". Questions that request information are those that ask others to state their knowledge in a way that the questioner can comprehend effortlessly. For example, "Let us know about..." These types of questions asked tutors to explain "simply" or "so I can comprehend effortlessly". These show that learners were aware that they did not have some basic necessary knowledge. In other words, these questions imply that the immediate antecedent of these questionings could be metacognitive experience: monitoring, and in particular, awareness.

However, the response of the tutors to questions that requested information caused, in some cases a transformation of the questions into ones that desired to confirm interpretation. These types of tutor responses were characterized by criticisms upon learners' cognitive actions and subsequent suggestions about these same cognitive actions. This transformation implies that learners' predictors of the state of their understanding transformed from ignorant noncomprehension into a degree of comprehension, though somewhat untrustworthy, that evidenced growth of constructive knowledge. This is evident because the questions that confirm interpretation are questions that learners ask in order to confirm their own state of understanding. For example, one of the students in the study, who engaged in learning about the binary system, asked the following: "I suppose that all information is represented as one or zero. If so, is hiragana or katakana represented as one or zero?" The latter questions imply that learners attempted to seek out criterion that referenced evidence of their comprehension. That is, although the questioners monitored the state of their understanding, they could not evaluate the trustworthiness. Therefore the immediate antecedent of these questionings could be also metacognitive experience, i.e. monitoring.

In the above-mentioned questions, the immediate antecedent is monitoring. However, as far as the criterion referenced evidence of cognitive progress is concerned, the former monitoring is different from the latter monitoring at a certain level. The former monitoring is evidenced by the learner performing monitoring functions without the criterion-referenced evidence. The learner attempting to monitor with criterion-referenced evidence characterizes the latter monitoring. Therefore the latter is at a higher level than the former. Hence, the latter learner might develop his metacognitive experience.

Tutors' response and their metacognition

We have tried to analyze questions that requested information and the responses of the tutors. Let us recall the tutors' responses to these questions. These responses were criticisms on learners' cognitive activities and suggestions for the learners' future cognitive activities. The criticism

of, for example "Do it yourself. Have you looked it up in books or dictionaries?" implies that the tutor has monitored the learner's cognitive actions through his question and criticized the learner's insufficient cognitive action. Moreover the suggestions, for example "you should make things you are uncertain of clearer", shows how the learner should regulate his cognitive actions.
Consequently, tutors' responses are their metacognitive experiences to which learners' cognitive actions provided input or which can exert influence on learners' cognitive actions. As learners develop a conscious cognition of the tutors' responses, these responses can be exhibited in the learners' externalized metacognitive experiences.

Communication and the development of metacognition

We now consider how the communication between learners and tutors develops learners' metacognitive experiences.

Although learners asked questions which depended on tutors to supplement their cognitive actions, the tutors didn't comply. This shows that the meaning which learners gave their questions is different from the meaning tutors gave. Thus learners noticed the difference in meaning which tutors gave and they reinterpreted discourse events; i.e. their questionings (Fox 1987). This reinterpretation would cause either reflective thinking or monitoring.

We must make the distinction clear between reflective thinking and monitoring before describing the process of developing learners' metacognitive experiences. We can distinguish reflective thinking from monitoring as "criterion-referenced". Reflective thinking is to think backward carefully about one's cognitive actions in the past. However monitoring is to evaluate one's cognitive actions with one's criterion-reference. Thus monitoring is a meta-level action, but reflective thinking is not.

We believe that criterion-referencing is the discerning factor by which reflective thinking turns into monitoring. To developing monitoring abilities means the development of a new criterion-reference. If a tutor's response has impacted a learner's reflective thinking through the conscious cognition of the tutor's criterion-referencing, the learner's reflective thinking could be the cause of his monitoring. If so, he would monitor using the tutor's criterion. During this process of monitoring utilizing the tutor's criterion, a learner gradually internalizes it as his own criterion. Then the student is able to do monitoring by himself. This process is the identical to Vygotsky's theory (Vygotsky, 1978).

> "Every function in the child's development appears twice: first, on the social level, and later on the individual level; first, between people (inter-psychological) and inside the child (intra-psychological)".

Conclusion

We have proposed two elements in this paper. The first is that the learners' questions represent their immediate antecedent cognitive actions and the tutors' responses represent their externalized metacognitive activities to which learners' cognitive actions provided input or which can exert influence on learners' cognitive actions. The second is how the communication between learners and tutors develops learners' monitoring. If learners notice the difference in meaning engendered in the tutor's response to their questioning, and they engage in conscious cognition of the tutors' externalized metacognitive experiences, the learner's reflective thinking elicited by the tutor's responses produces monitoring by the learner utilizing the tutor's criterion.
These two points are based on only two kinds of questions and answers. Although there are many additional kinds of questions, we are quite certain that most of the learners who do not develop their monitoring abilities ask these two types of questions.

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